NAVFAC
Naval Facilities Engineering Command
Engineering Service Center

Welding Emissions in Shipbuilding and Repair

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Outline

- **Why Worry About Welding**
- **Example Projects**
- **Where Are We Going from Here**

Plating & Welding Similarities

Welding Parameters	Electroplating Parameters
Base Metal, Weld position	Base Metal, Substrate
Consumables/filler (Rods & Wire) Source of most fume	Plating Bath Composition Source of all/most emission
Voltage, Polarity, Electrode Angle, Steady vs. Pulse current	Bath Temp, Amperage
Type of Welding & Shield Gas	Bath Mixture
Arc Time (inches/minute), torch travel speed, wire speed	Residence Time (min in bath)
OSH Operator: 100% engaged	OSH Operator: few minutes/hour
Environmental Emission Factors Being Developed	Environmental Emission Factors Developed

Why Worry About Welding?
It's not just about Hexavalent Chromium

Welding Rods Lawsuits

Contact an Attorney to Discuss Your Claim

Home | Practice Areas | Free Online Consultation | Contact An Attorney | Legal Disclaimer

Welding fumes have been linked to Manganism: A form of Parkinson's disease often called welder's disease.

Free Welding Rods Lawyers Consultation

If you have been exposed to manganese fumes and suffer from symptoms of Manganism or Parkinson's disease, you may be entitled to monetary compensation. To contact an attorney who will review your claim fill out our free case evaluation form provided below. An attorney with the Sheff Law Offices, P.C. will review your claim and may contact you to discuss your rights.

Free Consultation

AREAS OF PRACTICE

- Definition: Manganism
- Manganese Exposure
- Manganese Exposure Limits
- Manganese Welding Rod Fumes and Manganism: A Historical Causal Analysis
- Manganism Symptomology and Epidemiology
- Manganism Versus Parkinson's Disease
- Tests For Manganese Exposure
- Welder's may Be Entitled To Monetary Compensation
- Welding and Welding Fume Illness

http://www.weldinglawsuits.com/

Driving Regulations (the Dry Stuff)

- **OSHA 1910.1026 – Hexavalent Chromium Regulation**
- **OSHA 1910.1000 – Limits for Air Contaminants**
  - e.g. Manganese, Nickel, Copper, other stressors to long term health
- **CA AB 2588 Toxics Hot Spots Rule – Reporting**
  - at least 26 Navy & USMC sites reporting (most not for metals)
- **Residual Risk & Technology Review – CAA 112(f)(2)**
- **EPA Metals & Material Fabrication Area Source Rules**
  - Most DOD facilities do not exceed the 25,000 ton reporting threshold
  - No visible fume emissions w Opacity readings
- **EPA Shipbuilding and Repair Industry MACT**
  - expansion to include welding being considered.
  - Speculation a different MACT that includes welding

Emission Factors

EF = FRG x % Cr in Consumable x Annual Usage

EF = Emission Factor (Most Conservative of several)

FGR = Fume Generation Rate (g fume /g electrode consumed

- **FCAW - wire feed w/flux inside the wire, flux shields weld**
  - **Sometimes also uses a shield gas**
- **SMAW – rods, outer coat combines w/ air shielding weld**
  - **aka Stick**
- **GMAW - solid core wire feed w/ shield gas,**
  - **aka MIG w/ He, Ar and/or O shield gas**
  - **aka MAG w CO_2 shield gas**
- **GTAW –uses shield gas, but low emissions**
  - **aka TIG**
- **SAW – lowest rate, solid wire weld covered with flux material**

- **High Velocity Fume Extraction Guns *(P2 Project)***
  - **Controls well**
  - **Welder acceptance concern about disturbing shield gas**
  - **Bulky & some ergonomic concerns**
  - **Recent developments in lighter weight guns**

NSRP /EWI Efforts

In prep for Cr+6 OSHA regulation

OSH Focus w/ Reasonable Economic Data

- **NSRP 0457 Characterizing Shipyard Welding Emissions and Associated Control Options, August 1995**
- **NSRP 0463 Impact of Recent and Anticipated Changes in Airborne Emission Exposure Limits on Shipyard Workers. March 1996**
- **NSRP 05425 Welding Fume Study Final Report, June 1999**
- **EWI Project Estimated Relative Cost of Engineering Controls to Reduce Exposure to Manganese and Hexavalent Chromium, January 26, 2003**

Pulsed Power Inverters (ESTCP WP- 0212)

- Not a significant difference in fume reduction
- May be in increase in weld production
- Project developed useful information on weld sizes and speciation

LA AQMD & CA ARB Efforts

- **Development of Emission Inventory for Metal Welding, Cutting and Spraying Operations, May 31, 2000**
  - **Limited EFs Hexavalent Chromium, No EFs for Cadmium**
  - **Good EFs for Total Chromium, Nickel, Lead and Zinc**

- **Improving Welding Toxic Metal Emission Estimates in California, Chang et. al., 14 July 2004**
  - **UC Davis for CA ARB – Dr Dan Cheng (retired)**

- **Preliminary research using TMS/TEOS to control Cr(VI) emissions from arc welding**
  - **D. P. Chang at UC-Davis demonstrated 64% reduction in Cr(VI) when 1.4-1.6% TMS was added to shield gas**
  - **Preliminary research at UF has demonstrated between 75-93% reduction in Cr(VI) for 1.0-3.0% TEOS (Tetraethyl orthosilicate) additive to shield gas (supported by KIGAM)**

Ohio State SERDP WP1415 Effort

Fume Collection

Fume collection hood used for measuring FGRs and collection for phase identification w/XRD.

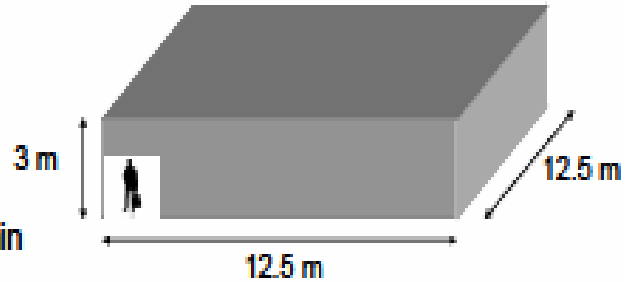
What is the significance?

Wet chemistry and XRD analyses show that E308-16 contains substantial Cr(VI) levels whereas Ni-Cu based consumables do not.

Using the new PEL of 5 µg/m³, and a weld time of one minute, this example illustrates the reduction of Cr(VI) achieved with the new electrode.

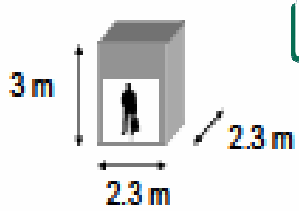
E308-16 (1/8")

- 80A, 24V
- Weld time 1 minute
- FGR 0.091g/min
- 2.6 wt-% Cr(VI)
- Cr(VI) generation rate 2400 µg/min



Ni-Cu-Pd (1/8")

- 110A, 25.5V
- Weld time 1 minute
- FGR 0.41g/m
- 0.02 wt-% Cr(VI)
- Cr(VI) generation rate 82 µg/min



DoD EPA DOE SERDP

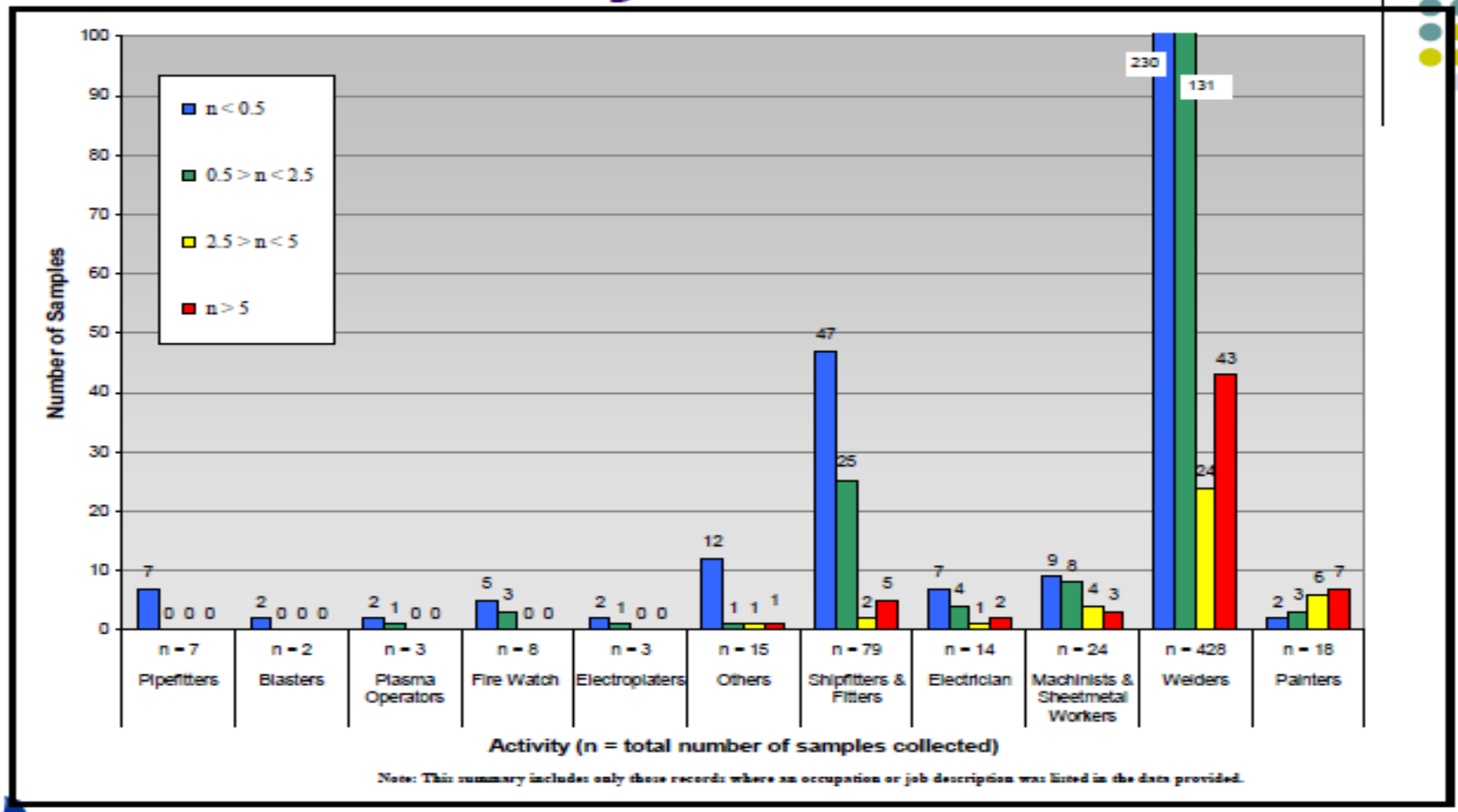
- **Navy Compliance with National Emission Standards for Hazardous Air Pollutants (NESHAP) for Shipbuilding and Ship Repair, Final Gap Analysis Report, Economic Impact Report and Final Task Technical Report**
  - **September 8, 2006, Joint Service Initiative (JSI) Project N5**

Atrium

Job Description	N = # Samples
Firefighters	7
Electricians	2
Plasma Ops	3
Fire Watch	8
Electroplaters	3
Other	15
Shipfitters & Fitters	79
Electricians	14
Welders	428
Machinists & Sheet Metal Workers	24
Painters	18

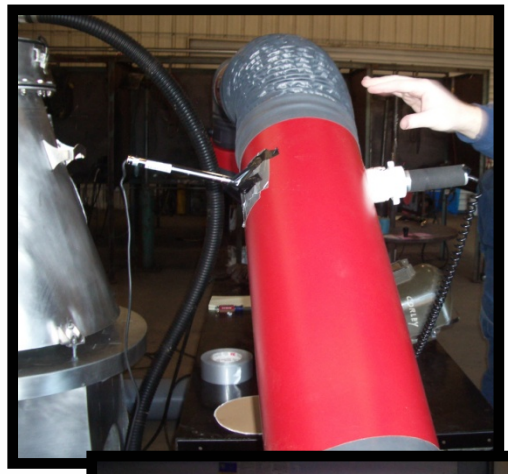
NSRP Hexavalent Chromium (CrVI) Survey, Dan Chute, Atrium Envi Health & Safety Service LLC, March 5, 2008

Distribution by Trade

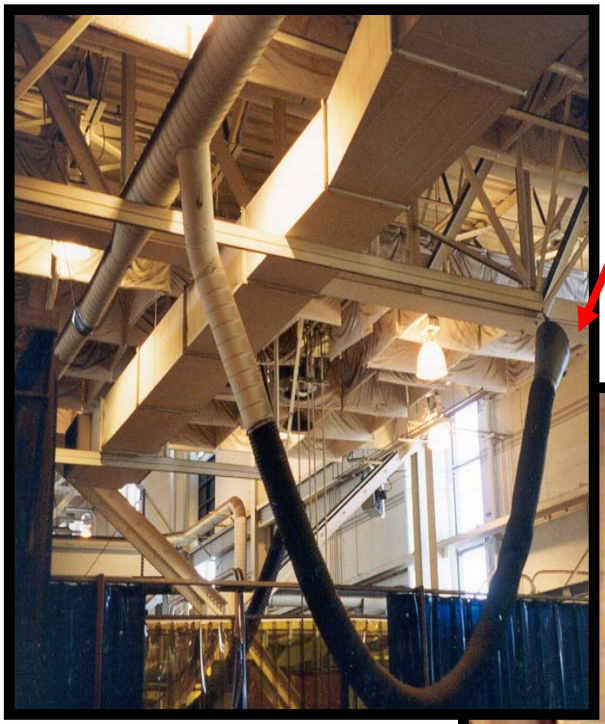


NDCEE/CTC Efforts

- **Shipbuilding and Ship Repair Industry Initiative to Prepare for and Comply with the Residual Risk Rule Making**
  - **July 18, 2008, NSRP ASE Program, Tested Lincoln Mobiflex & Miniflex Collectors**
  - Limitations & data gaps found current AP-42 data set
  - Current emission factors use multiple studies data w/ variable sampling forcing EPA to use conservative assumptions for regulatory decisions
  - Data collected during the NSRP RRR project demonstrated lower emissions than current AP-42 and proposed RRR emission factors

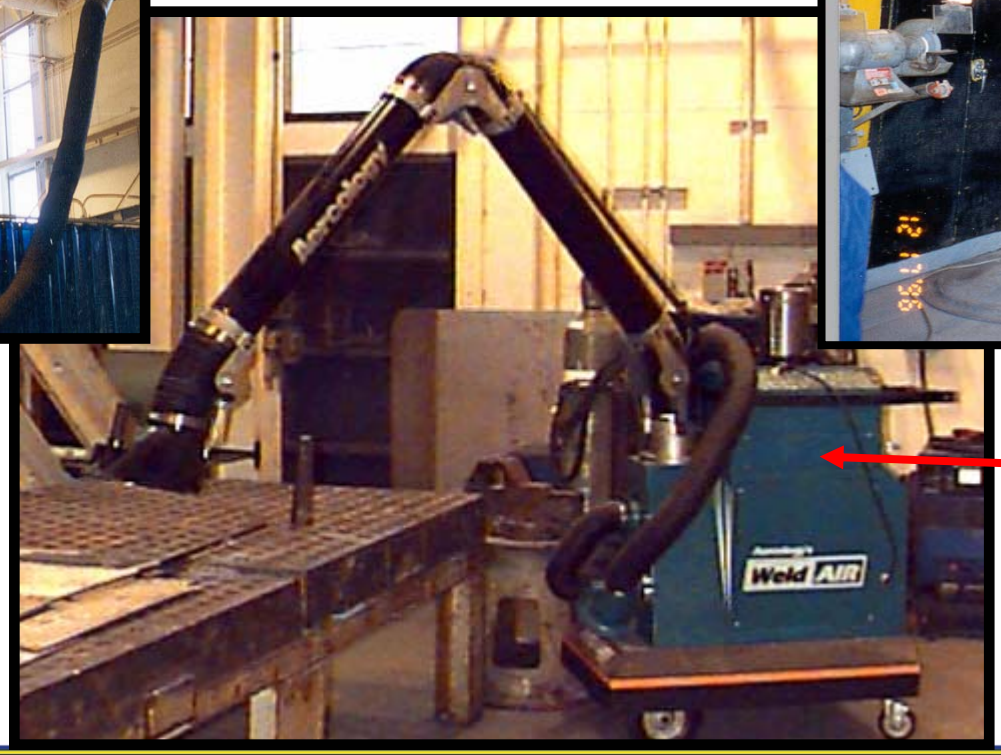


Why Worry?



Suction Hood Inlet

Pedestal Fan



Try wrestling this down a ship's ladder while carrying a power pack.

Consumable Development History

Initial composition: Ni-7.5Cu-1Pd

- *Good corrosion and mechanical properties*
- *Some solid-state cracking issues*
- *Marginal operability*
- *Porosity in the coated electrode (SMAW) deposits*
- *Pd is very expensive*

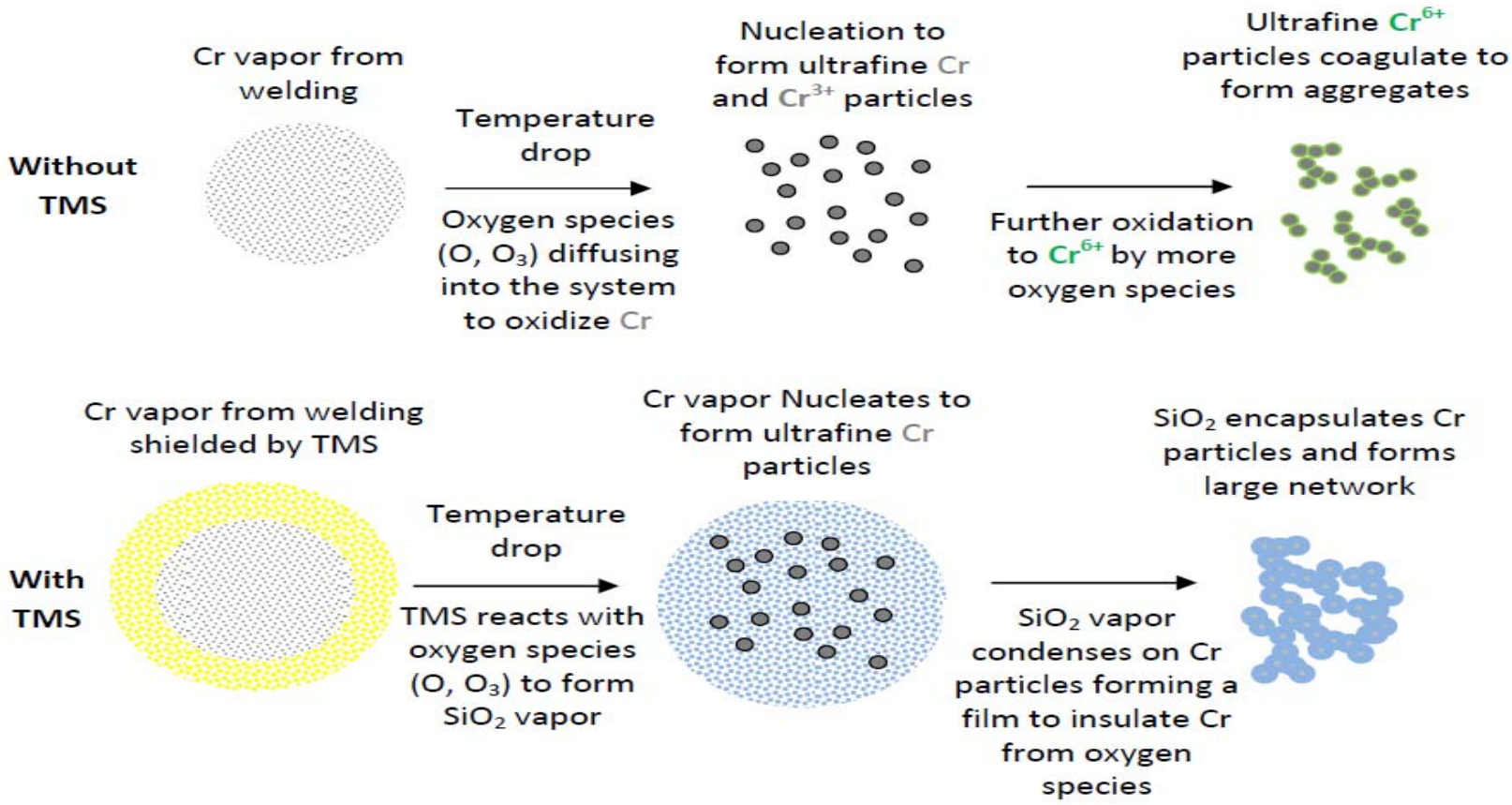
Current composition: Ni-7.5Cu-1Ru-0.5Ti-0.5Al-0.02C

- *Good corrosion and mechanical properties*
- *Improved cracking resistance*
- *Virtually no porosity in SMAW deposits (Ti effect)*
- *Variable operability based on coating type*
- *Reduced consumable cost*

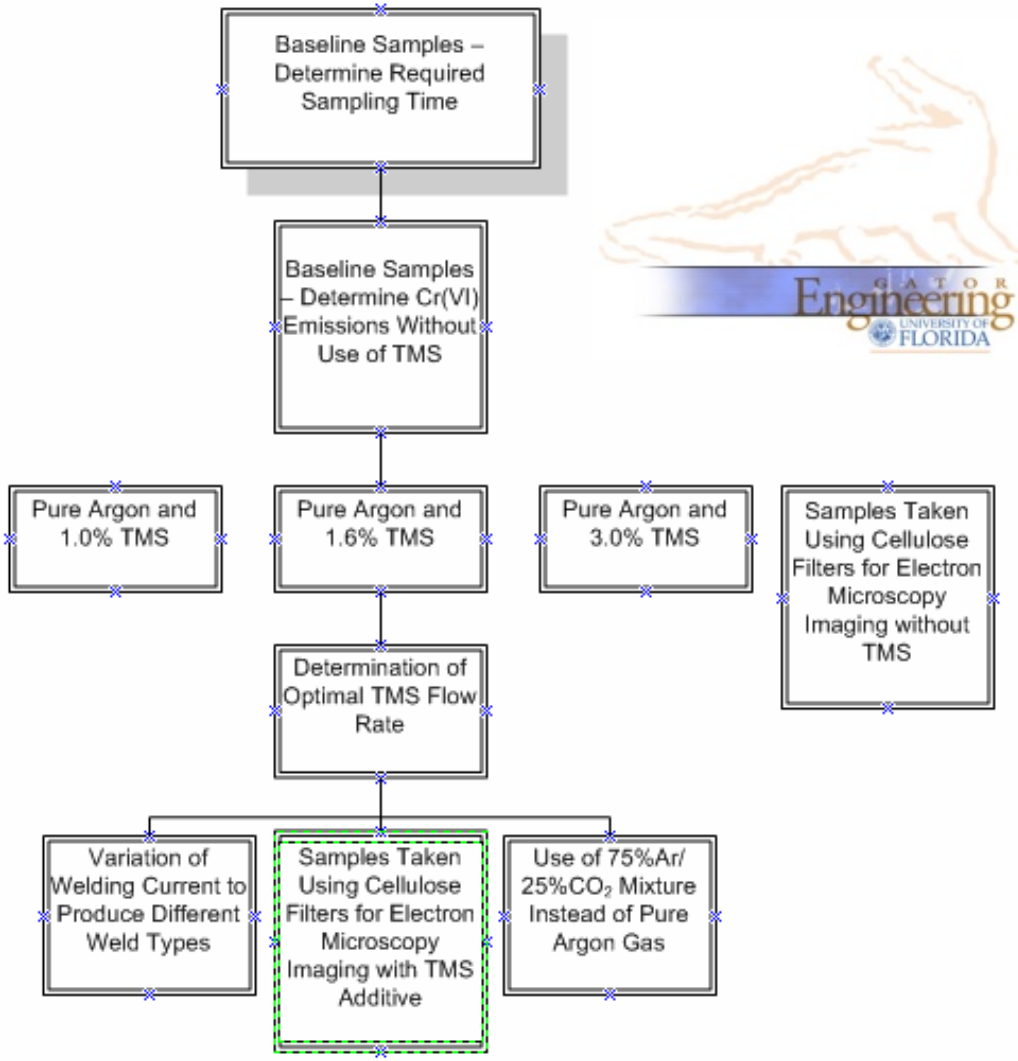
Laboratory Test Plan

- Coating formulation optimization
  - Operability (deposition rates)
  - Freedom from porosity
  - Reduced fume generation rate
- Measurement of Cr(VI)
  - SMAW over operating range of consumable
  - GTAW or other processes of interest to DoD
- Welding of "mockups"
  - Mechanical testing
  - Inspection standards

U of Florida/Dr. Chang-Yu Wu Trimethlysilicane Additive to Shield Gas



What Next? U of Florida Efforts 2009 New Start



TMS Optimization

- Determine optimal TMS feed rate for minimized Cr6+ formation

- Verify minimal influence from variation of operating parameters: welder power level, rod consumption rate and Ar/CO2 mixture

- Verify mechanical properties of weld are not adversely affected by TMS

Evaluate each technology's ability to reduce fine particle exposures & metal emissions while maintaining weld quality

- **Determine baseline conditions at three DOD facilities using their existing process.**

1. **Compare technologies at same three DOD facilities**
   - **IH Samples (Metals & Ozone) - near field and far field will be evaluated at no cost by NMCPHC (formerly NEHC), or university lab.**
2. **Envi Samples (Metals, Ozone& CO_2) - evaluated by independent test organization (contractor or university).**
   - **NAVFAC ESC will develop specific testing methodology (particle sizes, metals, etc) in Year 1**
3. **Weld Chemistries, metallurgy and mechanical qualities**
   - **Evaluated at NSWC Carderock**

- **Tech Transfer for the Ni-Cu-Ru consumable and TMS additive introduction into DoD operations**
  - **Development of procedure qualification records (PQRs) and weld procedure specifications (WPSs) for various DoD applications (field trials)**
  - **Development and approval of a consumable specification (e.g. AWS ENiCu-8, MIL XXXXX)**